2D - Momentum

$p = mv$ - Vector

$\Delta p = F_{net} \Delta t$ - area under graph

$\sum p_i = \sum p_f$

↑ Vector sum or components ↗ - require diagrams

$\sum p_{xi} = \sum p_{xf}$

$\sum p_{yi} = \sum p_{yf}$

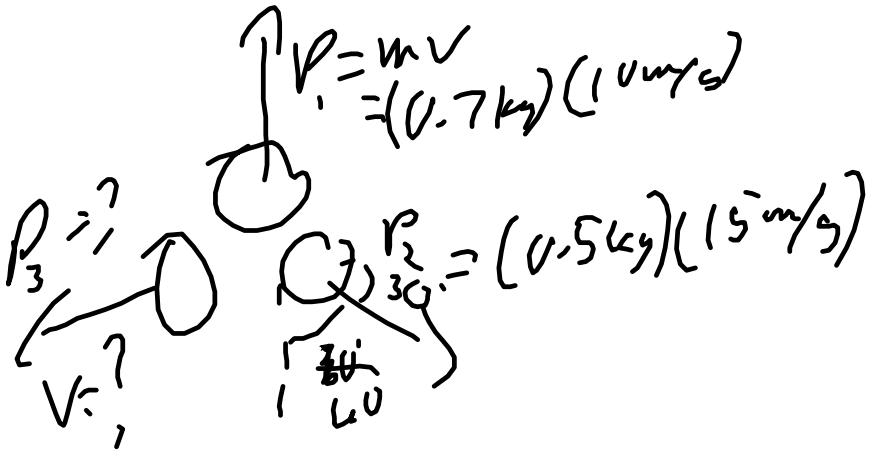
Eg. 1. A grenade, 2.0kg, explodes into 3 pieces.

- a 0.70kg piece goes North

at 10.0m/s, a 0.50kg piece goes 30.0° South of East at 15.0m/s. What is the speed of the last piece? direction?

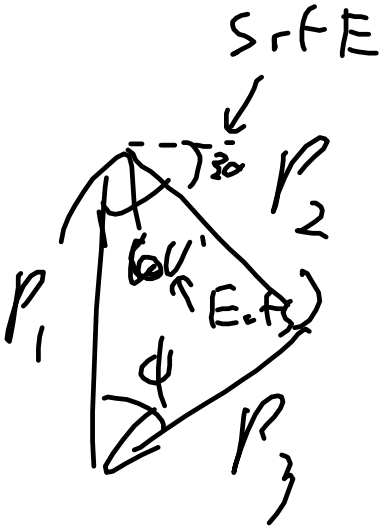
2. A 1500kg car is moving Northat 20.0m/s and collides with a 2000kg truck moving East at 15.0m/s. What is the speed + direction of the truck after the collision if
a) stick together
b) car bounces off at 12.0m/s 20.0° E of N.

1. $\sum p_i = 0$



$\sum p_i = \sum p_f$

$0 =$ Vector Sum



$p_3^2 = p_1^2 + p_2^2 - 2 p_1 p_2 \cos 60°$

$\frac{\sin\phi}{p_2} = \frac{\sin 60}{p_3}$

$p_1 = 0.7\,kg \times 10\,m/s$
$= 7\,kg\,m/s$

$p_2 = 0.5\,kg \times 15\,m/s$

$p_3^2 = 7^2 + 7.5^2 - 2(7)(7.5)\cos 60°$

$P_3 = 7.26\ kg\,m/s \quad V = \frac{P}{m} = \frac{7.26}{0.8kg}$

$V_3 = 9.1\ m/s$ 9.0786

$\frac{\sin\phi}{7.5} = \frac{\sin 60}{7.26} \quad \phi = 63.42°$

$V_3 = 9.1\ m/s$ 63° WofS

2000kg

2 → 15m/s

$P_2 = 3\times10^4\ Ns$

20m/s ↑

1 → $P_1 = 3\times10^4\ Ns$

1500kg

c)

$\sum P_i = \sum P_f$ ✗ Collision explode

~~Perfectly elastic $\sum E_{k_i} = \sum E_{k_f}$~~

~~Perfectly elastic $\Sigma E_{k_i} = \Sigma E_{k_f}$~~

$P_2 = 3 \times 10^4$

$P_1 = 3 \times 10^4$

$P_f = \sqrt{3^2 + 3^2} \times 10^4$

$P_F = 4.2426 \times 10^4 \text{ kg m/s}$

$V = \frac{P}{m} = \frac{4.2426 \times 10^4}{3500 \text{ kg}}$

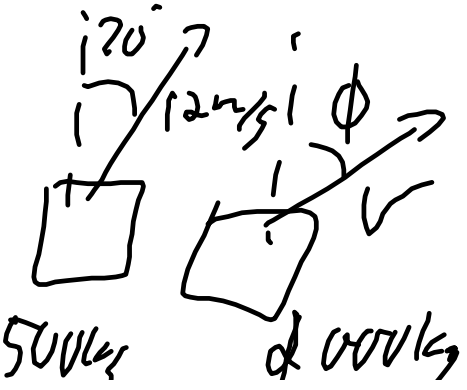
$V = 12.1 \text{ m/s}$

45° E of N

b) Perfectly inelastic - Stick together

$P_2 = 3 \times 10^4$

$P_1 = 3 \times 10^4$



before

1500kg 2000kg

final

$$\sum p_{x_i} = \sum p_{x_f}$$

$$3 \times 10^4 \text{ kg m/s} = 1500\text{kg} \times 12\text{m/s} \sin 21^\circ + 2000\text{kg} \, v_{x_f} \sin\theta$$

$$\sum p_y = 3 \times 10^4 \text{ kg m/s} = 1500\text{kg} \times 12\text{m/s} \cos 21^\circ + 2000\text{kg} \, v_y$$

$$v = \sqrt{v_x^2 + v_y^2} \qquad \theta = \tan^{-1} \frac{v_x}{v_y}$$